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Ninety-six subjects were assigned randomly to eight groups of 12 subjects. The independent variables were (1) controlled association strength between groups of words within a string (high association [HA] versus low association [LA]), (2) syntactic structure (grammatical [G] versus ungrammatical [U] strings), and (3) instructions (ordered learning and recall [O] versus free learning and recall [F]). Each subject received four study-test trials on a 21-word string. On a measure of serial recall, the HA condition was superior to the LA condition; the G condition was superior to the U condition; and the O condition was superior to the F condition. Association and grammatical structure interacted significantly, indicating that the effect of associative strength was greater for G than for U strings. On a measure of total word recall without regard for serial constraint, recall of HA words was superior to recall of LA words; recall of words from G strings was superior to recall of words from U strings; but the main effect of Instructions was not significant. There was significant interaction between grammatical structure and learning-recall instructions (grammatical structure facilitated O recall more than F recall). These results suggest that there are limiting factors on the facilitating effects of grammatical structure and associative strength on sentence recall. (Author/DO)

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ASSOCIATION, SYNTAX, AND INSTRUCTIONS IN SENTENCE RECALL[1]

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96 subjects were assigned randomly to 8 groups of 12 subjects in a 2 x 2 x 2 factorial design. The independent variables were (a) controlled association strength between groups of words within a string (high association--[HA] vs. low association--[LA]), (b) syntactic structure (grammatical--[G] vs. ungrammatical--[U] strings), and (c) instructions (ordered learning and recall--[O] vs. free learning and recall--[F]). Each subject received 4 study-test trials on a 21-word string. On a measure of serial recall, the HA condition was superior to the LA condition; the G condition was superior to the U condition; and the O condition was superior to the F condition. Association and grammatical structure interacted significantly, indicating that the effect of associative strength was greater for G than for U strings. On a measure of total word recall without regard for serial constraint, recall of HA words was superior to recall of LA words; recall of words from G strings was superior to recall of words from U strings; but the main effect of Instructions was not significant. There was significant interaction between grammatical structure and learning-recall instructions (grammatical structure facilitated O recall more than F recall). These results suggest that there are limiting factors on the facilitating effects of grammatical structure and associative strength on sentence recall.

It can be hypothesized that the speaker of a natural language when faced with the task of memorizing and later retrieving a sentence in that language, has available a number of devices that are likely to facilitate the task. The devices of interest here are primarily those (a) that increase the size of the memory unit, and (b) that facilitate construction of the correct response during retrieval.

For example, in the case of storage, (a) intonation contours act as cues to phrase boundaries and thus should facilitate recoding of words into phrase chunks, (b) identification of the overall syntactic structure of the word sequence should permit him to recode the words into a single serially organized syntactic chunk, (c) knowledge of rules of semantic interpretation should permit him to assign a single meaning to the words in a phrase or in the sentence as a whole, and (d) some word sequences are associatively integrated, i.e., they represent sequences experienced in the past and, therefore, do not require new learning.

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As for retrieval, in addition to the effects of the storage factors, (a) the speaker's recollection of the syntactic structure of the sentence together with the syntactic constraints exerted by items already recalled, should reduce the number of alternatives he has to select from to determine the form class of a word he is having difficulty remembering, and (b) his recollection of the meaning of the sentence, its associative structure, and the semantic and associative constraints exerted by items already recalled, should reduce the number of alternatives he has to select from within a form class in trying to construct a word he is having difficulty remembering.

Evidence for the independent operation of syntactic and associative factors in the recall of four-word strings comes from a study by the investigator (1966). Number of strings recalled (all words recalled correctly and in their original order) and total word recall was greater for grammatical strings (e.g., Strong lions roar fiercely) than for ungrammatical strings (e.g., Fiercely lions strong roar), and greater for strings of associatively related (free association norms) words than for low association sequences. The absence of interaction between association and syntax indicated that the recall of high association-ungrammatical materials was superior to the recall of low association-ungrammatical materials.

This, it appears that even when syntactic rules (and, of course, intonation contours and the rules on which the semantic interpretation of a whole sentence are based) were violated, the presence of associatively related items facilitated recall. It is reasonable to hypothesize, however, that this effect--at least in the case of recall of whole strings--is not likely to withstand the increased demands placed upon serial memory as the length of an ungrammatical string is increased. The present study was an attempt to evaluate this hypothesis in the case of 21-word strings within which were included groups of associatively related or associatively unrelated words. Further, the strings were grammatically or ungrammatically structured, and subjects were given either free learning-free recall instructions or ordered learning-ordered recall instructions. The inclusion of the instruction variable was for the purpose of determining to what extent the facilitating effect of syntactic structure is dependent upon the requirement that words be learned and recalled in order.

Method

Subjects and design. The subjects were 96 undergraduate students (volunteers) who were randomly assigned to 8 groups of 12 subjects each. The variables of

Association (high vs. low), Syntax (grammatical vs. ungrammatical) and Instructions (free vs. ordered learning and recall) were combined in a 2 x 2 x 2 factorial design. The subjects in each condition were tested in groups of 6.

Materials. To increase the generality of the results, two sentences with similar syntactic structure were constructed for each level of association, using the investigator's (1965b) associative sentence norms. The norms were constructed by giving subjects sentence frames containing only the noun of the form adjective-noun-verb-adverb. Their task was to associate an adjective, a verb and an adverb to the noun in each sentence frame. High Association (HA) strings were then constructed by selecting adjectives, verbs, and adverbs from the top of the associative hierarchies, and Low Association (LA) sentences by selecting items with comparable Thorndike-Lorge (1944) frequency and length from the bottom of the associative hierarchies. Each of the 21-word strings used in the present study contained within it either three HA sentences or three LA sentences. For example, an HA string was the little baby cried loudly while the old maid worked slowly and all the young children played happily with their parents, and an LA string, the lovely baby fell angrily while the kind maid washed calmly and all the poor children watched silently with their boats. The noun at the end of the HA strings was a high-strength free associate of the subject of the third underlying sentence (e.g., children-parents), while the comparable item in the LA strings was a low-strength free associate (e.g., children-boats).

The grammatical (G) condition consisted of the HA and LA strings, while the ungrammatical (U) condition consisted of the same strings with the words arranged randomly, with the exception that the content words in the underlying sentences occurred contiguously so as to facilitate scoring for serial recall (e.g., loudly baby little cried).

The strings for the various conditions were printed in booklets, one to a page. Each booklet consisted of four repetitions of a string, four blank lined sheets for the written recall tests and filler sheets. The signals to turn the pages and the recall signals were recorded on magnetic tape.

Procedure. All subjects received four study-test trials on one of the experimental strings. Half of the subjects in each condition learned the first string and half learned the second. The exposure interval was 10 sec., the interval between the end of the study interval and the beginning of written recall was 4 sec., the recall interval was 90 sec., and the intertrial interval

was 12 sec. All subjects were told that they would be exposed to a verbal passage and that their task was to try to learn as many of the words in the passage as possible. The subjects in the free learning--free recall (F) condition were told to learn and recall the words in any order, while the subjects in the ordered learning and recall (O) condition were instructed to learn and recall the words in the order in which they appeared in the passage. All subjects were urged to guess at items they could not remember. Detailed instructions in the use of booklets were administered, and the signals to turn pages and to begin and end the recall tests were delivered to the subject by tape recorder. The various conditions of the experiment were administered in rotation.

Results

The measure of serial recall was the total number summed over the four trials of underlying sentences recalled correctly. An underlying sentence (e.g., little baby cried loudly; loudly baby little cried) was scored as correct if all four content words were recalled correctly and in the order in which they appeared in the original passage. With the exception of minor spelling errors, scoring was for verbatim recall. Table 1 contains the means for this measure for the various experimental groups. In general, it can be seen that O recall was superior to F recall, HA was superior to LA and G was superior to U.

Insert Table 1 about here

Although the distribution of scores in Group LAU-F was extremely skewed, it was felt that there was nothing to be gained by transformation or by the use of a non-parametric statistic (Edwards, 1960). Accordingly, a factorial analysis of variance was carried out on the data for the serial recall measure. The effect of Instructions was highly significant, F (1,88) = 33.37, $p < .001$, as was the effect of Association, F (1,88) = 29.20, $p < .001$, and Grammar, F (1,88) = 349.54, $p < .001$. The interaction between Association and Grammar was significant, F (1,88) = 7.81, $p < .01$, which indicates that the effect of Association was greater for G strings than for U strings, but none of the other interactions was significant.

To determine the level of recall of individual items without regard for serial constraints, the recall protocols were scored for the total number of

content words recalled correctly (summed over the four trials) without regard for location on the recall sheets. The means for this measure can be found in Table 2. Table 2 reveals that recall of HA words was superior to recall of LA words, recall of words from G strings was superior to recall of words from U strings, but that 0 recall was superior to F recall for words from G

Insert Table 2 about here

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strings while F recall was superior to 0 recall for words from U strings. The effects of Association, $\underline{F}$ (1,88) = 31.99, $\underline{p} < .001$, and Grammar, $\underline{F}$ (1,88) = 94.11, $\underline{p} < .001$, were found to be significant, but not the effect of Instructions. The only interaction to reach significance was the interaction between Grammar and Instructions, $\underline{F}$ (1,88) = 6.13, $\underline{p} < .025$; the facilitating effect of grammatical structure was greater for 0 recall than for F recall.

Discussion

The results of the present study are discussed below for each of the separate independent variables.

Association. As anticipated, the facilitating effect of association on serial recall in the case of long strings was greater for grammatical strings than for ungrammatical strings. However, the effect of associative strength was the same for grammatical and ungrammatical strings when recall was scored without regard for serial constraints. Thus, it appears that subjects may recall associatively related words better than associatively unrelated words but have difficulty arranging them in proper order when the words appear in long ungrammatical strings.

Grammar. The effect of grammatical structure on ordered and free recall for the serial recall measure was striking. However, when recall is scored without regard for serial constraints, the effectiveness of grammatical structure is reduced if subjects are not required to learn and recall items in order. These results suggest that it may be useful in verbal learning studies to distinguish between the effects of grammatical structure and the effects of the requirement that the structure be used in learning and recall.

Instructions. Instructions appear to be an important variable in serial recall regardless of level of association and grammatical structure. However, it is clear from the results for total word recall that the effect of learning and recall instructions is upon the serial organization of items in recall and not upon the probability of recall of items. These last results are not

consistent with the common observation that free recall is superior to ordered recall in the case of word lists. The reason for this discrepancy is not clear, however. One hypothesis to be tested is that it reflects the nature of the materials used.

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Footnote

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Table 1

Mean Number of Underlying Sentences Recalled Correctly

	Instructions O	Instructions F
HAG	9.58	8.58
LAG	7.75	4.92
HAU	2.92	.83
LAU	1.92	.08

Table 2

Mean Number of Words Recalled Correctly

	Instructions O	Instructions F
HAG	46.92	46.00
LAG	42.75	39.17
HAU	33.42	39.17
LAU	28.17	29.33